ICIS based limits for Heat at Labadie

Ameren invested heavily in modeling of heat for a Mixing Zone using one fourth of the width of the Missouri River. Numeric heat criteria for the Missouri require that heat at the end of the MZ not exceed 5°F (ΔT) and peak temperature of the MZ must not exceed the cap of 90°F (Tmax).

Limits in the NPDES permit were based on equations that mathematically "best fit" the model outputs for matching the ΔT and Tmax limits based on river flow, effluent flow, and anticipated temperatures of river background and heated effluent. Ameren created a calculated factor, the Thermal Discharge Parameter (TDP) that modeled the limits. With the consideration of a 5% margin of safety, the PDP was used as the calibrated limit in the permit and the permit limit was set at TDP = 0.95.

The full permit and fact sheet are linked at:

[HYPERLINK "https://dnr.mo.gov/env/wpp/permits/issued/docs/0004812.pdf"]

Here is the key permit language that describes the limit:

Note 4: Thermal Discharge Parameter (TDP) is a derivation from site-specific model solutions of the thermal plume created by the discharge from Outfall #001 into the Missouri River. Thermal Discharge Parameter represents a combination of stream flow, stream temperature, effluent flow, and effluent temperature, as defined by the equations below, in which the mixing zone is less than 25% of the receiving flow. The numeric effluent limitation, 0.95, incorporates an additional five percent margin of safety to ensure compliance with the water quality standards for temperature, maximum of 90°F and maximum change of 5°F, at the edge of the thermal mixing zone. Additional requirements are found in Special Condition #19. TDP shall be calculated using the following equations (exact permit language permit in smaller, Times New Roman font):

When Ts < 80°F:

$$M2 = 0.00005275\,(Te - Ts)^2 - 0.00544551\,(Te - Ts) + 0.19336524$$

When 80°F ≤ Ts ≤ 85°F:

$$M2 = 0.00005275\,(Te - Ts)^2 - 0.00544551\,(Te - Ts) + (-0.000200\,Ts + 0.209365)$$

When 85°F < Ts < 90°F:

$$M2 = (-0.00001055 * Ts + 0.00094950)\,(Te - Ts)^2 - (-0.00108910 * Ts + 0.09801913)\,(Te - Ts) + (-0.03847303 * Ts + 3.46257232)$$

For all equations, when the difference between effluent temperature (Te) and stream temperature (Ts) is less than 25°F, (Te – Ts) shall be set to 25°F. The difference between effluent temperature (Te) and stream temperature (Ts) shall not exceed 50°F.

Qe =	Effluent flow from Outfall #001 in cfs.
Te =	Effluent temperature from Outfall #001 in °F.
Qs =	Stream flow minus intake flow in cfs.
Ts =	Stream temperature in °F.
M1 =	(Qe / (Qs + Qe))
TDP=	(M1 / M2)

MDNR has requested that the TDP limit be converted to a limit that can be entered into the ICIS compliance database using existing parameter codes.

Attached is a spreadsheet listing the ICIS parameter codes related to heat discharges. Where we have suggested a conversion to a more standard limit, the suggested ICIS code is highlighted.

Calculation of the $\Delta T = +5°F$ limit

For the $\Delta T = +5°F$ limit, the TDP = 0.95 has been used. A mathematic conversion can be used:

$\Delta T°F$ at end of MZ = 5.26 TDP (5/0.95)

Using the permit language of Note 4, this approach could be used to set permit limits at temperatures below 85°F:

When $Ts < 80°F$:
$$M2 = 0.00005275\,(Te - Ts)^2 - 0.00544551\,(Te - Ts) + 0.19336524$$

When $80°F \leq Ts \leq 85°F$:
$$M2 = 0.00005275\,(Te - Ts)^2 - 0.00544551\,(Te - Ts) + (-0.000200\,Ts + 0.209365)$$

Using the rest of the procedure above, the permit would require the calculation of TDP.

$\Delta T°F$ at end of MZ = 5.26 TDP **Limit = 5°F (ICIS Parameter Code 03772, Unit Code 15)**

For temperatures above 85°F, Ameren altered the M2 calculation to consider the 90°F Tmax. This becomes a switch in assessment of compliance with temperature limits, but from the standpoint of standards, both requirements apply.

We suggest that for $\Delta T°F$ at end of MZ the second equation above could be used, and the temperature range extended so that $\Delta T°F$ is calculated at flows above 85 $\Delta T°F$:

When $Ts \geq 80°F$:
$$M2 = 0.00005275\,(Te - Ts)^2 - 0.00544551\,(Te - Ts) + (-0.000200\,Ts + 0.209365)$$

Using the rest of the procedure above, the permit would require the calculation of TDP.

$\Delta T°F$ at end of MZ = 5.26 TDP **Limit = 5°F (ICIS Parameter Code 03772, Unit Code 15)**

Calculation of the 90°F (Tmax)

To calculate the compliance with the Tmax temperature cap of 90°F, the following approach would be used as a derivation from the ΔT calculation for higher temperatures:

When $Ts \geq 85°F$:
$$M2 = 0.00005275\,(Te - Ts)^2 - 0.00544551\,(Te - Ts) + (-0.000200\,Ts + 0.209365)$$

Using the rest of the procedure above, the permit would require the calculation of TDP.

$\Delta T°F$ at end of MZ = 5.26 TDP

Tmax at the end of the MZ = 85°F + $\Delta T°F$ at end of MZ

Limit = 90°F (ICIS Parameter Code 00015, Unit Code 15)

--John Dunn, 3/3/19